Biennial Review 1987-89

Alberta
ENVIRONMENTAL CENTRE

The Alberta Environmental Centre is the province's major facility for applied environmental research, technology development and services. Officially opened in 1981, its 28,000 square metres of research facilities are located on a 300-hectare site in Vegreville, 100 km east of Edmonton. Funded through Alberta Environment, the Centre services all provincial departments and agencies which identify environmental problems requiring study. Specific projects are undertaken after review by a Technical Advisory Committee, and approved by a Board of Directors. The Centre's five Divisions — Plant Sciences, Chemistry, Animal Sciences, Environmental Technology and Common Services — accommodate over 300 staff carrying out studies to provide new knowledge for the solution of environmental problems.

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Biennial Review
1987-89

Alberta Environmental Centre
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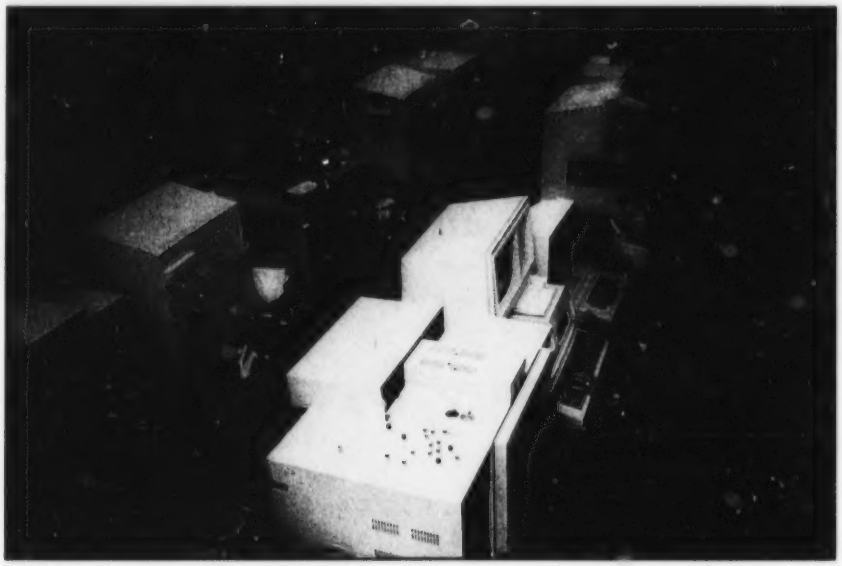
Introduction

The Alberta Environmental Centre, a major provincial scientific facility, provides research and analytical services as backup to the Alberta government in its role of protecting the environment in this province. Work at the Centre, whether research, service or technology development, is carried out at the request of "clients" — government departments and agencies, and through them for industry and the people of Alberta. The clients identify the environmental problem; Centre staff then use a variety of techniques, in laboratory and field work, to find practical and cost-effective solutions.

Although for organizational purposes the Centre is divided into five Divisions — Chemistry, Animal Sciences, Plant Sciences, Environmental Technology, and Common Services — technical programs and their projects are organized into nine program areas. The purposes and accomplishments of our programs for the 1987-89 period are described in this review. Highlights for each of the program areas are summarized in this introduction to serve as examples of Centre activities.

Researchers from different Divisions frequently work together to study problems. For example, during these two years, scientists from Plant Sciences and Environmental Technology continued their collaboration on a major land reclamation project. The success of that project has demonstrated the effectiveness of interdisciplinary research.



Gas chromatograph in Research and Methods Branch

Analytical, Diagnostic, Extension and Technical Services

- Wide range of capabilities to test for environmental contaminants, such as pesticides, inorganic substances, trace organic compounds, and microorganisms.
- Immediate response to emergency situations requiring analyses.
- State-of-the-art analytical and bioassay services to back up regulatory and enforcement agencies concerned with air and water quality.
- Identification of and control recommendations for problem weeds, insects, plant diseases, chemical damage to vegetation, and problem wildlife.
- Western Canada's only radioisotopes facility provides consulting and research services.
- Expertise in wildlife capture methods that minimize trauma.
- Publication of analytical procedures manuals and agricultural extension books.

Environmental Toxicology

- Inhalation toxicology facility opened to study the toxic effects of hydrogen sulphide (principal contaminant of sour gas) and other gases.
- Grass carp reared at the Centre and released for weed control in irrigation canals, reducing use of chemicals.

Pest Management Research and Development

- Research into economical and environmentally safe control of problem weeds, insects, plant diseases, and wildlife.

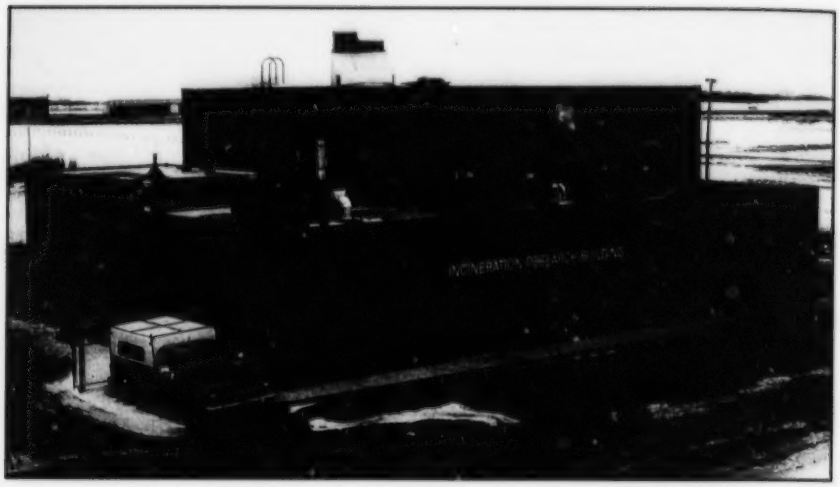
- Expertise in biological control of weeds and greenhouse insects to reduce reliance on chemicals.
- Research on how to manage herbicide residues in a crop rotation and on how to avoid residues in the soil.
- Commissioning of a headerhouse and three research greenhouses.

Living Natural Resources

- Canadian Council on Animal Care reviewed the terms of reference of the Centre's Animal Care and Use Committee.
- Field work completed on forage selection by elk in relation to land reclamation. Selection of appropriate seed mixes of native grasses to prevent elk from grazing along roadsides.

Land Resources Management Research and Development

- Reclamation solution found to deal with huge amounts of sludges generated by oilsands exploration.
- Reclamation studies of soils compacted by heavy machinery.
- Long-range project to minimize upward movement of salts into topsoils by certain crops in a rotation.
- Selection of native plant species for the reclamation of disturbed lands — industrial and recreational.

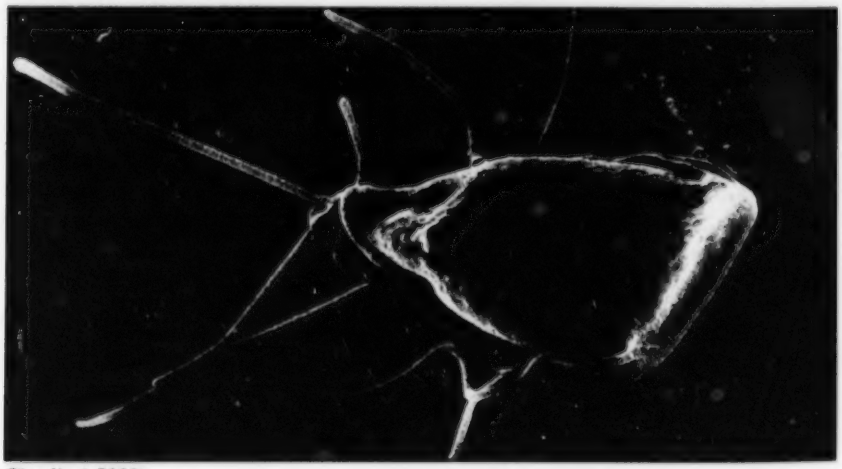


Waste Management Research and Development

- The Centre became a founding member of the Pacific Basin Consortium on Hazardous Waste Research.
- Incineration research facility commissioned.
- Expertise in stabilization technology for waste treatment led to contracts to work with the New Jersey Institute of Technology and with the U.S. Environmental Protection Agency.

Water/Wastewater Research and Development

- The Centre is known for its research on Giardia, a tiny protozoan which causes intestinal illness in humans. Fort Collins, Colorado, asked the Centre for help in the design of a water treatment plant because of a problem with Giardia.
- The Centre's two mobile water treatment plants used in solving drinking water problems.



Giardia (x7000)

- As part of an extensive aquatic biology program, the Centre developed bioassay tests to assess toxicity of contaminants in rivers or lakes.
- Confirmed that mercury contaminants in Alberta rivers come from cinnebar deposits in the mountains, not from industrial sources.

Technical Support

- Specialized services in support of research are: library, pathology, growth chambers and greenhouses, computers and instrumentation, photography and graphics, biometrics, site and vehicle services.

Administrative Support

- The Centre's clerical staff helped produce scientific papers, bulletins, procedures manuals and books, and organized symposia, workshops and international meetings.
- A high awareness of safety resulted in an excellent Centre-wide safety record.
- The Centre was given approval to receive external funding for research projects done cooperatively or under contract.

A Division's administrative support area

Analytical, Diagnostic, Extension and Technical Services

During 1987-89, staff ensured that the Centre maintained its reputation for high-quality analytical and diagnostic environmental services. Laboratory quality control programs constantly verified work done for internal and external clients.

In addition to several continuing programs, many of the Centre's analytical services were available on an emergency basis. No matter what the day or time, when industrial accidents or public health emergencies occurred Centre staff were made available to perform analytical work.

Water and Air Analytical Services

With a total of 12,893 samples submitted in 1987/88 and 12,005 samples in 1988/89, water analysis was and is the Centre's largest analytical service. Treated and non-treated drinking water samples were analyzed for two major clients, Alberta Environment's Pollution Control Division and the Public Health Units.

The water analysis laboratory participated in five major research projects at the Centre in 1987/88 and seven major research projects in 1988/89, developed ten new analysis methods, and provided analytical support within 72 hours for over 40 environmental and health-related emergencies, as well as continued hydrogen sulfide (H_2S) method development and research. In 1988/89 the Water Analysis Branch produced a major performance report on its Quality Assurance and Quality Control (QA/QC) program.

Water quality testing

Air samples collected province-wide by Alberta Environment's Air Quality Branch were analyzed at the Centre. The sampling network includes fixed monitoring stations near large industrial areas and mobile stations placed wherever they are needed. In 1987/88, approximately 7,000 samples were analysed, and approximately 6,600 in 1988/89.

An in-depth study of organic chemicals in air was undertaken in 1988/89, in response to odour and health complaints in the Fort McMurray area of Alberta.

Years of testing have shown that, in general, Alberta's air quality is very good and does not have health-threatening background levels of any known pollutant. By providing a state-of-the-art analytical service, the Centre plays a key role as backup to the regulatory services which ensure that the province's air quality continues to meet high standards.

The Centre also provides analytical services to Alberta Environment's acid deposition monitoring program and participates in the Long Range Transportation of Airborne Pollutants (LRTAP) program. Staff carried out analyses of precipitation samples and performed related monitoring and

equipment calibration as a service to other groups. State-of-the-art methods were established for analyzing 12 parameters in precipitation samples.

Trace Organic Analysis

Although pollutants such as polychlorinated biphenyls (PCBs) are chemicals of high public concern, only traces were found in Alberta; such low concentrations do not cause adverse human health effects.

The Centre's analytical capability extends to many chemicals. A total of 1,136 samples were analyzed in 1987/88 and 1,191 samples in 1988/89. The major clients of the service are Alberta Environment's Environmental Protection Services and the Public Health Units. Projects included investigations of hydrocarbon and PCB spills, screening of industrial effluents to ensure licence compliance, and identification of organics in five Alberta river basins.

Microbiology

The microbiology service identifies bacteria and fungi for internal and external clients. In 1987/88 almost 600 samples were analyzed. A unique computerized microbiological identification service was also established. Provision of analytical services for microbial enumeration, identification, and toxicity testing continued in 1988/89 involving the analysis of about 750 samples.

Microbiology staff were involved in a long-term cattle feedlot wastes project which concluded during fiscal year 1987/88. A predictive model was developed to determine the impact of feedlot wastes on water quality. A draft report containing the detailed results and findings of this study was completed in 1988/89.

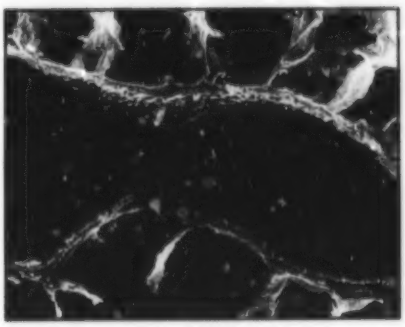
In 1988/89 research on microbial processes in waste management involved studies on chromium removal from sewage sludge using bioreactors, evaluation of a peat-based, on-site wastewater treatment technology, and detection of odour-causing compounds of microbial origin in piggery waste.

Electron Microscopy

The Centre's electron microscopy facility provides identification and chemical analysis services to clients. The bulk of the work supports research done at the Centre. However, requests from external clients such as Health Units, Alberta Agriculture and the University of Alberta increased each year.

Submissions included identification of bacteria, determination of possible air pollutants on air filters, description of fungi that cause plant diseases, evaluation of fungi used in biodegradation of industrial wastes, analysis of effects of hydrogen sulphide gas on mammalian lungs, characterization of heavy metal waste immobilization in cement matrices and effect of ozonation on Giardia cyst inactivation.

In 1988/89 submissions included identification of the interaction of bacteria with alpine grass roots, viruses in plant material, and analysis of mushrooms grown on cellulosic wastes.



Rat lung bronchiole (x300)

Environmental Isotopes

The Centre is the only facility in western Canada providing consulting and research services based on carbon and hydrogen radioisotopes for the solution of environmentally related earth science problems.

That expertise is provided to various Alberta government agencies with some capacity available on a fee-for-service basis to the private sector. Because such laboratories are few and far between, the services in 1987-89 were used by clients across Canada and the United States.

Ongoing work includes support for soil salinity research conducted by the Alberta Research Council and a major effort in developing the radiocarbon chronology of Head-Smashed-In Buffalo Jump, a World Heritage Site near Fort Macleod. The isotope laboratory is also working with the provincial government departments of Environment and Culture on the Old Man River Dam Project. The work is aimed at defining the environmental and cultural consequences of the river valleys to be flooded.

Dig site at Head-Smashed-In Buffalo Jump

For private industry, the laboratory carried out work for the environmental impact assessments of a major new pulp mill in Alberta and for a radioactive waste depository in the USA.

Pest Management

The Centre is the regional laboratory for pest diagnostic services in north-central and northeastern Alberta. Pest Management's staff identify weeds, insects and plant diseases. During the 1987-89 period, pest diagnostic submissions handled were 941 insects, 1,578 plant diseases and 736 weeds. Presentations on pest control were made to farmers, vegetable growers, livestock producers, interior landscape specialists and the general public at conferences, regional meetings and agricultural fairs.

The Centre also has responsibility for chemical damage diagnosis for the entire province. As aerial spraying of crops has become more popular, the incidence of chemical damage to vegetation because of spray drift has increased and so has the demand for this diagnostic service. Centre staff do not assign blame for chemical damage nor assess damages; they provide diagnoses only and may act as expert witnesses if claims go to trial. During this period 815 submissions — comprised of 1,966 plant, soil and water specimens — were processed for cases of suspected chemical damage to garden plants and crops.

The Centre produces publications on pest management for farmers and backyard gardeners. One major publication, prepared in 1987/88, is an expanded update of the book Insect Pests of Alberta. It was published in 1989 by the University of Alberta as Insect Pests of the Prairies.

Technical Services — Animal Sciences

Toxicology, aquatic biology and wildlife biology services were consolidated under Technical Services in 1988 to provide support to internal research programs and directly to external clients.

Analytical toxicology, which involves the analysis of organic and inorganic substances in biological materials such as tissues and fluids, complements existing services in pathology and animal resources (see Technical Support section). One hundred eighteen aquatic bioassays were conducted during 1987-89 in support of regulatory or enforcement activities of Alberta Environment and Alberta Forestry, Lands and Wildlife (AFLW). Another 112 were done in support of research. Expert advice was provided for several investigation and enforcement activities under the authority of the Clean Water (Alberta) and Fisheries (Canada) Acts. Staff also participated in field and laboratory investigations of fish mortality incidents, algal blooms and other miscellaneous inquiries.

Centre staff have also developed expertise in wildlife capture methods that minimize trauma. That service has been used by a variety of provincial and federal government departments and agencies. In 1988, Centre staff were consulted on the safe capture of caribou, mountain goats, and wolves for wildlife management purposes. In 1989, staff assisted AFLW in the formulation of a

management plan for Alberta's grizzly bear population. Assistance was provided to both the Canadian Wildlife Service and AFLW in the capture of mountain caribou in the Jasper area. Centre staff also played a major role in organizing the 1989 meeting of the Northwest Section of the Wildlife Society held in Banff in 1989.

Work continued on the development of the analytical toxicology laboratory to provide analytical services for organic and inorganic contaminants in biological matrices. Methods development work continued in the extraction, cleanup and analysis of biological samples by gas chromatography, high pressure liquid chromatography and atomic absorption spectrophotometry. Procedures were developed for the determination of mixed function oxidase activity, for the determination of trace concentrations of copper, selenium, and vanadium, and for the determination of acetylcholinesterase activity in red blood cells. In addition, more than 12,000 analyses were conducted by the biochemistry laboratory.

Wildlife capture net shot from helicopter

Over 200 telephone enquiries were responded to for general information concerning environmental toxicology. Staff assisted in risk assessment and clean up procedures for spills of hazardous chemicals and conducted field investigations as required on chemical contamination incidents.

Quality Control/Quality Assurance

All laboratories at the Centre devote a great deal of time and resources to quality assurance and quality control. Quality assurance is an integral part of laboratory operations and quality control procedures are essential to ensuring that the results generated are valid and can be relied upon by the clients of the laboratory.

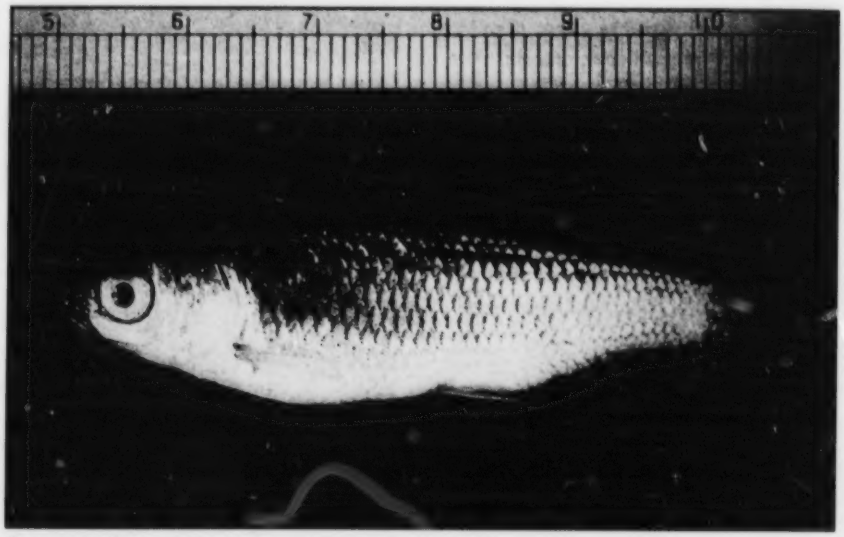
Environmental Toxicology

When natural or man-made substances enter our environment, whether planned or by accident, it's important to know what their effects will be. Scientists in the environmental toxicology program study the toxicity of many chemical and biological substances to ensure a safe environment in Alberta.

Inhalation Toxicology

This program determines the toxic effects of gases, vapours, particulates and aerosols on man and animals. The Centre is one of only three laboratories in Canada with the capability for industrial-scale investigations of the toxic effects of inhaled gases. The program was originally developed as a response to public concern for environmental and occupational health associated with uncontrolled emissions of sour natural gas. The major focus of the program continues to be the toxic effects of hydrogen sulphide (H_2S), the principal contaminant of sour natural gas. Studies have been completed on the acute toxic effects of H_2S.

Four new studies were carried out during 1987-89. In cooperation with the University of Calgary, two studies on the mechanisms of action of hydrogen sulphide were conducted. These studies focussed on the effects of vagal nerve transmission blockade on the induction of acute pulmonary oedema. A third study concluded in cooperation with the University of Alberta examined the effects of hydrogen sulphide directly on the nervous system.



Grass carp fry

The emphasis of the H_2S work shifted during 1988 from acute (short-term) to subacute (intermediate term) studies. A five-week study was completed at concentrations simulating occupational and environmental exposures. Work was also undertaken to complete the laboratory and statistical analysis and report writing phases of a study on the effects of H_2S on airway function and bronchial reactivity.

The change in focus from short- to long-term will be continued. Plans were developed for a multigenerational study of the effects of H_2S on reproduction to begin in early 1990. This study will include exposures up to 90 days duration.

Planning commenced on a study of mechanical systems which would be required for the exposure of large domestic animals, to help determine the effects of H_2S on such animals involved in a "blowout" incident.

Staff from the Centre also participated as members of the Sulphide Research Network in planning a major international conference on Hydrogen Sulphide Toxicity held in Banff in 1989.

Chemical Safety Evaluation

The Chemical Safety Evaluation Program provides a comprehensive safety and (sometimes) efficacy evaluation of chemical and biological substances of environmental concern. In addition, this program provides safety evaluations of candidate chemical and biological products under regulatory review.

During these two years, considerable effort was put into the development of Tier I regulatory bioassays as defined by Canadian, U.S. and OECD[1] regulatory

[1] *Organisation for Economic Cooperation and Development*

agencies. It is intended that these procedures be made available on a fee-for-service basis to Canadian companies to assist in the development of industry in western Canada. The procedures include a wide variety of acute toxicological studies to evaluate the toxic and infective potential of candidate substances to man, birds, domestic animals and wildlife. Standard operating procedures and type protocols were developed for most Tier I tests. Work was completed on fifteen Tier I studies of a specific candidate biological herbicide under regulatory review.

Toxicology of Biocides

This program studies the effects of commercial pesticides on non-target species. A recent novel application of the program has been to assess the feasibility of using biological alternatives to replace chemical weed control agents.

At the request of the Irrigation Secretariat of Alberta Agriculture, 5000 grass carp fry were obtained from Florida and were maintained for a full year under quarantine. Grass carp are an herbivorous fish originating in China which have been used in tropical and semi-tropical climates for control of vegetation in drainage, irrigation and navigation channels. The current study attempts to determine the feasibility of using grass carp to control aquatic weeds in irrigation canals in southern Alberta as an alternative to chemical and mechanical weed control.

The imported carp fry were maintained with low mortality for the full quarantine period during which health assessments were undertaken and studies were made of the effects of different water temperatures and feeding regimens.

In order to ensure that released carp are not able to establish a breeding population in competition with indigenous fish, the ploidy (genetic) status of 1500 fish was determined prior to release. Those grass carp found to be triploid (having 1.5 times the normal number of chromosomes) and thus unable to breed were released in a controlled field trial in dugouts in southern Alberta.

Completed or under review during these years were reports and journal manuscripts involving the environmental chemistry and toxicity of methoxychlor to fish, the effects of exposure of wild birds to insecticides used for grasshopper control and the effects of dichlorvos on blood cholinesterase activities of cattle. A study of the effects of Ciodrin® on cholinesterase activity in cattle was underway.

Toxicology of Petroleum and Fossil Fuels

The toxicity of crude oils and chemicals used in oil extraction and refining and in the coal mining industry is an important Alberta concern. At the request of Alberta Agriculture, the program focussed on the toxic effects of crude oils and drilling fluids on cattle exposed by pasture contamination.

During acute toxicity testing, it was found that while there are some serious effects when cattle consume large quantities of oil, consumption of small amounts is relatively harmless.

Work continued in three studies of the acute toxicity of a selected Alberta crude oil to cattle. Tissue enzyme biochemical analysis were completed and methods were developed for hydrocarbon analysis of tissues. Analytical work was also completed on the effects of crude oil on liver enzyme activities. Changes were found in the activities of important liver enzymes including P-450, aryl hydrocarbon hydroxylase and methoxycoumarin.

The live-animal phase of two studies of the acute toxic effects of diethylene glycol and methanol in cattle was completed. Laboratory analysis is underway.

Facilities and apparatus were designed and constructed for a study on the behaviour of cattle allowed voluntary consumption of crude oils.

Pest Management Research and Development

At the Centre, finding environmentally safe and economical methods of protecting plants and animals from pests is a top priority.

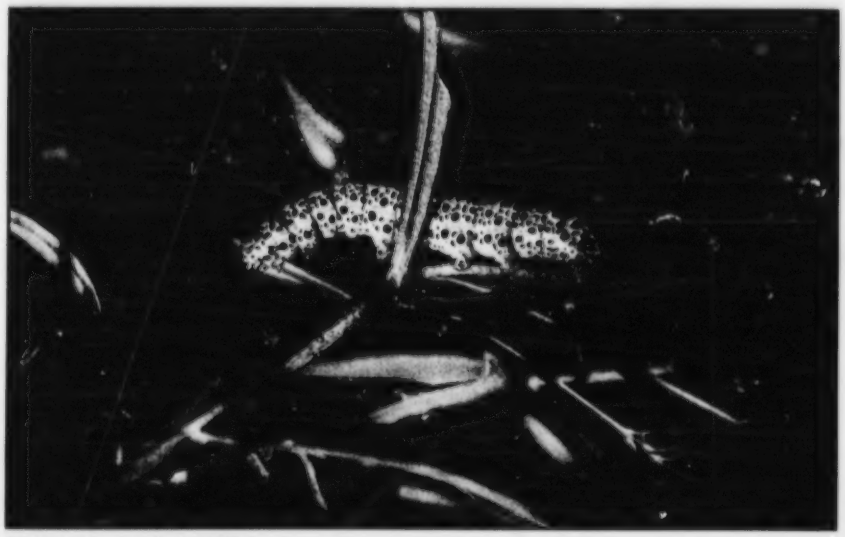
Plant Diseases

To develop effective methods for plant disease prevention and control, field, laboratory and growth chamber experiments were carried out on a number of crop diseases. The work included performance evaluation of new and registered fungicides for disease control, and plant disease surveys to detect newly introduced diseases and to maintain surveillance of established diseases. Some of the disease problems studied included virulent blackleg and seedling blight of canola; root rot and septoria leaf blotch of wheat; net blotch of barley; crown and root rot of alfalfa and sainfoin; and Verticillium and Fusarium wilts of alfalfa.

When the diagnostic service noted an increased prevalence of foliage diseases, research on controls for these diseases was initiated. Preliminary findings suggest that the increase in foliage diseases is likely related to the increase of minimum tillage practices which allow the disease-causing organisms to live through the winter.

Weeds

To gain background information on Alberta weeds, Centre scientists used field and growth chamber experiments and surveys to determine the magnitude of weed problems and the economic losses due to weeds. One such study evaluated the effect of volunteer barley, volunteer wheat and quackgrass growing in canola crops. Decreases in crop yield and losses in income were quantified by computer models.



Biological control of toadflax

Fundamental work on the biology and ecology of weeds, for example round-leaved mallow, scentless chamomile and corn spurry, was the foundation of many practical applications including the determination of a threshold level for a particular weed — the maximum weed density that can occur in a crop before damage to the crop is economically significant. That information can save farmers time and money on control measures.

Some herbicides, though effective in killing weeds, persist too long in the soil and can damage next year's crop. Research on weed control strategies to avoid herbicide carry-over included field and growth chamber experiments on new herbicides such as Glean®, Ally®, Amber® and Muster®. As part of that work, chemical damage diagnostic techniques were developed to study herbicide response and injury symptoms in crops and weeds.

Other work focussed on managing herbicide carry-over using activated charcoal, a particularly useful method for spot treatments. A study was done on the factors influencing the efficiency of activated charcoal.

In areas where weed control with herbicides is not appropriate, biological control of weeds may be the answer. Research was directed at field testing of plant-feeding insects imported from Europe, where most problem weeds and their natural enemies originated. The insects selected and tested were screened in Europe to ensure their safety for non-target species

in North America. They were again thoroughly tested under quarantine by Agriculture Canada's Research Station in Regina, Saskatchewan. A root-feeding beetle was used against leafy spurge, and other insects are under study for Canada thistle and common toadflax.

A survey of weed diseases in Alberta, funded by Farming for the Future, was initiated in 1988 to identify indigenous plant pathogens with potential as biocontrol agents.

Insects

Because of ideal temperature and humidity conditions, greenhouses are likely places for insects to cause major problems. Chemical insecticides are often not the best choice for indoor insect control. An integrated control strategy, such as biological control using predatory or parasitic insects combined with reduced amounts and/or number of chemicals was a goal of this study. As an example, the Centre commenced trials using a predatory mite to keep western flower thrips in check on cucumber plants.

Insect control on animals was advanced with the development of a new insecticidal ear tag to protect cattle from horn flies and a backrubber solution to protect them from black flies and other biting flies. Studies were undertaken to assess the effectiveness of these practical, on-farm controls.

Variety Trials

The Centre entered into a cooperative project with Alberta Agriculture by taking over the management of crop variety trials in northeastern Alberta. This new arrangement will allow Centre scientists to study the susceptibility of new crop varieties to insects and diseases before the varieties are licenced for commercial use.

Pesticide Analysis

Pesticide analysis was both an in-house service — for studies on pesticide application and chemical damage — and an external service for clients such as Alberta Environment and Alberta Agriculture. A total of 1,008 samples were analyzed in 1987/88 and 900 in 1988/89.

Identification and quantification are part of the analytical service. Centre staff operated on a stand-by basis to analyze pesticide samples immediately in case of an emergency.

Living Natural Resources

Understanding the biology and ecology of Alberta's fish and wildlife is key to the successful management of our living natural resources.

Ecological Studies

This program determines the effects of major physical changes in the environment on habitat, and on the stability and productivity of indigenous fish and wildlife populations.

The field investigation phase was completed of a study of a major new water control project (the Dickson Dam) and reservoir (Gleniffer Lake), constructed in 1983, on fish populations. This study showed that the lake did not support appreciable commercial or sport fisheries and that, unlike many reservoirs, there was no increase in methylmercury in fish upstream or downstream of the dam. Expert advice was provided with respect to the applicability of these data to other water control projects.

Work continued on a long-term study of possible mechanisms for controlling pocket gopher depredation. Three toxic substances were field tested for efficacy in burrow-located baits. Reports were produced concerning previously completed work on the use of toxic collars on sheep for controlling coyote depredation and on the use of egg and tallow baits for skunk control.

Data analysis and report writing were completed comparing Landsat and ground data in the analysis of forest habitats for wildlife. In cooperation with the Centre's Vegetation Branch, field work was completed on forage selection by wapiti (elk) in relation to land reclamation. Recommendations were made regarding seed mixes which would increase or decrease wapiti grazing as desired. Studies continued on the effects of tick-induced hair loss on the thermal properties of moose hide. A study of the behavioral patterns associated with estrus and estrus-detection in wapiti was completed.

Assistance was provided to Alberta Forestry, Lands and Wildlife for a study of potential repellents to reduce hare depredation of spruce seedlings. The repellents under study were found to be ineffective.

Humane Trapping

The humane trapping program was established to develop, improve and objectively assess candidate trapping devices intended to kill commercially important species of furbearing animals in a more humane way. A six-stage sequential assessment procedure has been developed which includes engineering studies, controlled in-laboratory studies using anaesthetized animals and simulated field trapping of selected species of furbearing animals. Traps which are found to meet rigorous criteria for acceptability are then tested in parallel with conventional traps in the field.

The "Bionic" trap, a large mousetrap-type killing device was found to meet the established criteria as a more humane trapping device for mink and fisher. This device now awaits field testing.

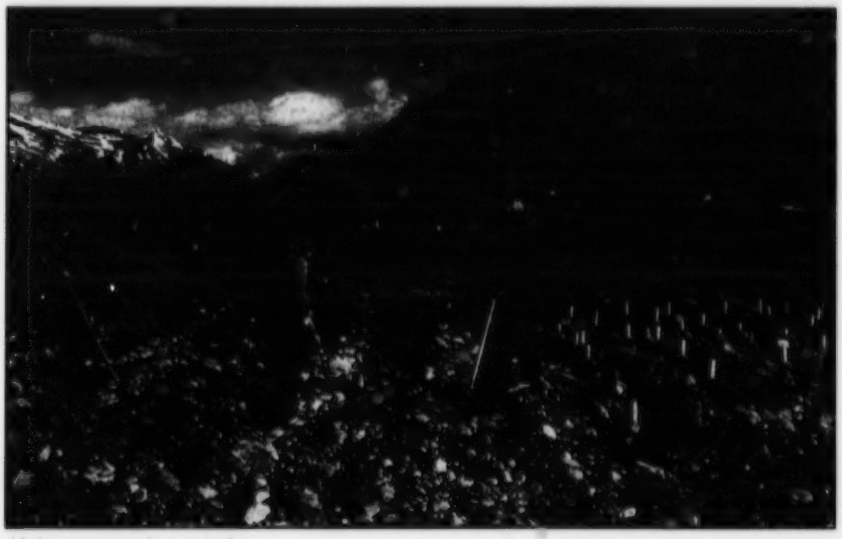
A modification of a commercially available rotating jaw trap (the Conibear) was found to be unsatisfactory for raccoons. A further modification of the rotating jaw trap which had previously been found to be satisfactory for mink under laboratory conditions was field tested in British Columbia and Newfoundland. A larger version of this device was found to be ineffective for fisher under laboratory conditions.

An evaluation of the ability of power snares to more humanely kill red fox was completed and a report prepared.

Land Resources Management Research and Development

The land resources of Alberta, including soils and vegetation, are second only to the human resources in their importance and contribution to a high standard of living. These resources must be protected and maintained.

Government regulations stipulate that following all activities which disturb the land, such as oil well drilling and mining, the land must be returned to its former productivity. The Soils and Vegetation Branches at the Alberta Environmental Centre specialize in developing practical solutions that allow for the full restoration of productivity and sustainability on disturbed, degraded or contaminated lands.



Alpine revegetation test plot

Soil Reclamation

Perhaps the largest reclamation problem in Alberta is located north of Fort McMurray where two oil sands extraction plants generate nearly 25 million cubic meters of "sludges" each year. Due to the fine particle sizes and residual bitumen, these sludges do not drain; they consist of two-thirds water and one-third solids. They represent an environmental threat to the northern waterways and wildlife populations and may leak into the groundwater causing its degradation. The best solution is to dry the sludges. Through a combination of freezing and thawing, surface drainage, and evapotranspiration by plants, staff at the Centre have pioneered a technology of dewatering the oil sands sludges. Field and lab work is in its fourth year of progress.

Another study deals with the reclamation of soils compacted as a result of the large and heavy machinery used in resource exploration and drilling, pipelining, and even in agriculture and forestry. Soil scientists are now quantifying the loss of crop production due to compaction and are developing standards for evaluating its seriousness. In the future, they will investigate ways of preventing and alleviating soil compaction.

The gradual salinization of land is another major reclamation problem. Two long-term research projects, located on agricultural soils and coal-mined lands, are underway to identify the best cropping systems to lower local groundwater levels, and thereby prevent the upward rise of salts and contamination of the topsoils.

The development of new pieces of equipment and new methods for measuring the capacity of soils to absorb environmental "shocks" continues to be a specialty of the Soils Branch. New equipment includes a root washer, a computer-based root image analysis system, and a soil penetrometer. Recently, work began on a down-hole salinity probe. A reliable laboratory method was developed for measuring the oil content of soils affected by accidental spills or used in land farming. A simple measure of water repellency in soils was developed for use in the field to characterize problems of oil contamination.

Native Species for Reclamation

The aim of the Centre's native species for reclamation program is to select, develop, and register plant material for the rehabilitation of disturbed lands in high-stress or sensitive environments. Any registered lines will then be made available to commercial seed growers.

Covering disturbed mountain areas with vegetation will solve reclamation problems but commercial varieties of forage grasses need regular management and often die in severe winters. Grasses that already grow in the mountains are more appropriate candidates for alpine reclamation.

By the summer of 1988, 15 lines of alpine bluegrass and 10 lines of wheatgrass had been selected as having reclamation potential in the eastern slope environment of the Rocky Mountains. These lines are now being evaluated for their reclamation potential. Seed production and other agronomic characteristics of the selected lines are being studied at the Centre with some financial support from the Canadian Parks Service.

In work related to the reclamation of saline sites, testing for salt tolerance in the collected plant material was completed. Seventy alpine bluegrass lines and eleven wheatgrass lines were selected as having potential. Initial field testing was done in summer 1989 and will continue through 1993.

Another project involved the requirements for seed germination in Saskatoon berries and other shrubs which are potentially useful for reclamation. Studies on the seeds of Saskatoon berry found genetic variation in germination among populations of this species. Further work will be undertaken to determine the optimum pre-germination treatment for the populations found to have the highest germination rates. Commercial Saskatoon growers will also benefit from these studies.

Waste Management Research and Development

The goal of projects in this area is to research and develop strategies for sound waste management. As part of this effort, the Centre became a founding member of the Pacific Basin Consortium on Hazardous Waste Research. The consortium is a group of 14 countries dedicated to sharing expertise on common problems of waste management and undertaking joint research projects.

Technology Development

One waste management strategy studied at the Centre is the use of incineration for on-site waste management. Experiments at the Centre's incineration facility will aid in the development of on-site incineration techniques, including emission control and residue characterization and treatment. Studies have been completed on the incineration of chlorinated hydrocarbons and sulphur hexafluoride in laboratory-scale equipment. The pilot facility was in the final stages of commissioning in 1988/89. In addition to the research at the Centre's incineration facility, studies have been carried out at the Alberta Special Waste Treatment Centre at Swan Hills to assess the quality of the incinerator performance data submitted in support of licencing and compliance.

An alternative to burning waste is solidification into concrete-like blocks. A major concern with any stabilization technology used in Alberta is to prevent water from penetrating the stabilized waste material and leaching out pollutants. The methods developed by Centre researchers for testing stabilization technology are now proposed as industry standards.

The Centre's expertise in this technology has led to collaborative work with the New Jersey Institute of Technology and with the U.S. Environmental Protection Agency.

Another waste management method is composting; Centre scientists are consulting on a pilot project in Ryley, a town in east-central Alberta.

Research on oriental edible mushrooms, grown on waste sawdust and straw, continued with field experiments in Brooks and Vegreville. Results showed the mushrooms did not grow as well in northern Alberta because of the lower soil temperatures. A follow-up project has been started to determine the feasibility of using off-season vacant space in commercial vegetable greenhouses for mushroom cultivation.

Work continued on developing biopolymers for waste treatment. Chitosan was one such biopolymer studied; it is a large molecule that is biodegradable and non-toxic. When added to water supplies, it settles out small particles and thus improves water quality. Until recently the only source of chitosan was the shells of shellfish. Centre researchers have identified a fungus that produces chitosan and have developed methods of growing the fungus and extracting the chitosan.

Fermentation production of chitosan

Water/Wastewater Management Research and Development

Research at the Centre is aimed at preserving and enhancing the quality of Alberta's environment through the development of sound management practices for water and wastewater.

Aquatic Toxicology

The Aquatic Toxicology Program determines the effects of industrial, municipal, and agricultural wastewaters on freshwater systems and on living populations which are dependent upon these systems.

Evaluation of ten reference toxicants has been carried out for four test species used in aquatic toxicity assays. The test species assessed included two freshwater molluscs (*Lampsilis radiata* and *Anodonta grandis*), a cladoceran (*Daphnia magna*) and an amphipod (*Gammarus lacustris*). The toxicity of other toxicants can be compared to the standard reference toxicants and a relative toxicity index determined. Standard reference toxicant assays have also shown that there can be considerable variation (±20%) in the response of some test species to these toxicants. This represents a "drift" in the sensitivity of the biological test systems and is an important factor in interpreting the results of such assays.

Studies were undertaken to provide pre-impact information at the sites of three proposed pulp and paper mills on the Athabasca River system. These studies are intended to provide background data on chemical constituents of the water and on fish species present, against which the future status of the river can be compared.

Molluscs for bioassay testing

Manuscripts were prepared on the regulation of the pulp and paper industry in Canada, the toxic effects of polychlorodibenzodioxins, and approaches to water and wastewater management in Alberta.

Chemical Residues

The chemical residues program is designed to determine the background levels of organic and inorganic chemical residues in Alberta's environment.

Work in this program during 1988/89 included the review of reports of several previously completed studies. One study investigated mercury concentrations. (Mercury contaminants in Alberta's rivers originate in cinnibar deposits in the mountains rather than from industrial sources.) Guidelines which were developed to advise anglers on safe consumption of fish were published with the Alberta fishing regulations.

In another project, work on DDT residues in peregrine falcons and their prey was completed. Results showed that although DDT has been banned in North America, falcons are still exposed to the DDT being used in their wintering grounds in Central and South America.

Potable Water Technology

A current threat to safe drinking water in Alberta is the presence of the protozoan Giardia. It causes giardiasis (popularly referred to as "Beaver fever"), a distressing intestinal illness.

The U.S. mountain states have Giardia problems similar to those in Alberta; in 1987, the City of Fort Collins, Colorado asked the Centre for assistance in the design of units to eliminate the problem in a water treatment plant.

Work on evaluating disinfecting agents and disinfection technology entered its third year in 1987. Studies were undertaken to increase the understanding of why some water treatment plants are more effective than others in removing Giardia cysts.

Giardia studies make use of the Centre's unique mobile water treatment plant, a small-scale plant equipped with commercial-scale (rather than experimental) water treatment equipment. Experimental results from the mobile plant are immediately applicable to large-scale water treatment plants.

In a cooperative project involving the Centre, the City of Edmonton and the University of Alberta's civil engineering department, experiments began at Edmonton's E.L. Smith Water Treatment Plant to assess the effectiveness of using activated carbon to remove unwanted taste and odour from drinking water. A test was developed to determine the concentration of powdered activated carbon in water treatment plant sludge. Results of the carbon work were promising for implementation on a large scale.

During this period, researchers began the commissioning of a smaller mobile pilot plant for field use. This plant employs ozone treatment in addition to settling and filtration. The plant was used in studies on colour, taste and odour control in drinking water treatment for Elk Island National Park.

Technical Support

To efficiently operate a large establishment like the Centre, many of the internal services are centralized and offered to all Divisions to limit duplication of services and allow for the development of specialized personnel.

Animal Resources

The care of experimental animals is a key component of research work in Animal Sciences. The Centre's animal facilities and procedures come under close scrutiny from internal and external committees and must meet national and international standards. Because of the variety of animals kept at the Centre — from laboratory rats to cattle — staff have developed a wide range of expertise in animal care.

Every study involving vertebrate animals is reviewed by the Centre's Animal Care and Use Committee before research can begin. In addition, the Canadian Council on Animal Care (CCAC) conducts regular inspections, announced and unannounced, of the Centre's facilities. The Council reviewed the terms of reference for the Centre's Animal Care and Use Committee and returned positive comments, and conducted a site visit of Centre facilities and procedures in March 1989. Several minor recommendations were made by the Site Visit Team to bring Centre procedures into line with current CCAC Policy. Overall the Centre's animal care and use program was judged to be exemplary.

Research greenhouses

The Centre Animal Care and Use Committee reviewed 42 protocols and 10 standard operating procedures during the year.

Considerable improvement was made to the temporary cattle facility to enable all-weather use. A study of the air handling system of the laboratory animal facility was conducted by an engineering consultant. Plans for modification and expansion of the laboratory animal facility were prepared. Enhanced software (ANUSE) was implemented in the Animal Resources Section to improve data collection on animal use. This software enables researchers at this Centre to collect data on experimental animals in a manner consistent with that at other major research institutions in Canada.

Pathology Services

In 1988, 723 necropsy (post-mortem) examinations were conducted on experimental animals. Approximately 8,500 tissues were subjected to histopathologic (microscopic) examination to detect evidence of changes associated with exposure to environmental chemicals under study.

In another important area of service, 1,277 blood and serum samples were analyzed for evidence of changes in blood cells and blood chemistry profiles. More than 6,000 results (individual pieces of data) were contributed to ongoing research programs. In addition, 1,455 blood samples from grass carp were analyzed for red blood cell volume (a measure of chromosomal status) and the results confirmed by individual chromosome counts of 160 selected

samples. Approximately 350 other cytologic samples were prepared and examined. More than 5,000 tissue species were prepared during post-mortem procedures for electron microscopy and some 300 were examined to arrive at conclusions.

Overall, pathology services contributed to seven major research programs. In addition to the experimental samples prepared and examined, some 30,000 quality control procedures were carried out to ensure the validity of the experimental data.

Controlled Environments

This service is responsible for the supervision and maintenance of the physical facilities required for raising plants. Staff also provide technical assistance and horticultural advice on the propagation of research plants.

Three new greenhouses were commissioned in 1987 and turned over to the Plant Sciences Division. Unlike commercial greenhouses, the Centre's greenhouses have separate rooms and environmental controls which make them suitable for research purposes. These facilities will significantly extend the range of projects the Centre can undertake.

The Centre continued to make extensive use of its 36 growth chambers for plant research requiring more exact environmental controls.

Computer and Instrumentation Services

In 1987/88, computer systems management was transferred to the Environmental Technology Division, the Division already responsible for repair and servicing of electronic equipment.

Complementing these responsibilities, Environmental Technology also took over the management of the main-frame computer system, offered an internal consulting service for the writing of computer programs, and continually updated Centre computer hardware and software.

Acquisition and installation of the control system for the new incineration facility was a major task completed. Priority was placed on implementation of an efficient system with an emphasis on safety.

Photographic and Graphic Services

The Plant Sciences Division provided technical support by producing high-quality computer graphics, photographic prints, and photographic slides for scientific conference presentations, poster displays, extension talks, and other meetings, as well as photographic plates and figures for scientific journals and technical reports. In 1987-89, approximately 2,800 specimen photographs, 1,050 slides from printed text, and 280 prints of graphics were produced. Assistance was provided to staff in the proper use of photograpic equipment, and in production of graphics with computer software packages.

Biometrics

Based in the Animal Sciences Division, a biometrics consulting service provided experimental design and data analysis to all Divisions. Studies were reviewed for statistical validity and choice of statistical methods before they were carried out. This quality control measure ensures that studies undertaken at the Centre produce reliable scientific data.

Site Support Services

Reassigned to Plant Sciences in 1988, the Site Support Section coordinated manpower, equipment, facilities and materials required to support research projects and the operation of outside facilities.

In addition to continuing work on vehicle and equipment maintenance, animal care, and the preparation of field plots, staff completed major modifications to the Centre's cattle facilities to handle larger numbers, and supplied equipment to the joint Plant Sciences/Environmental Technology oil sands sludge dewatering project.

Administrative Support

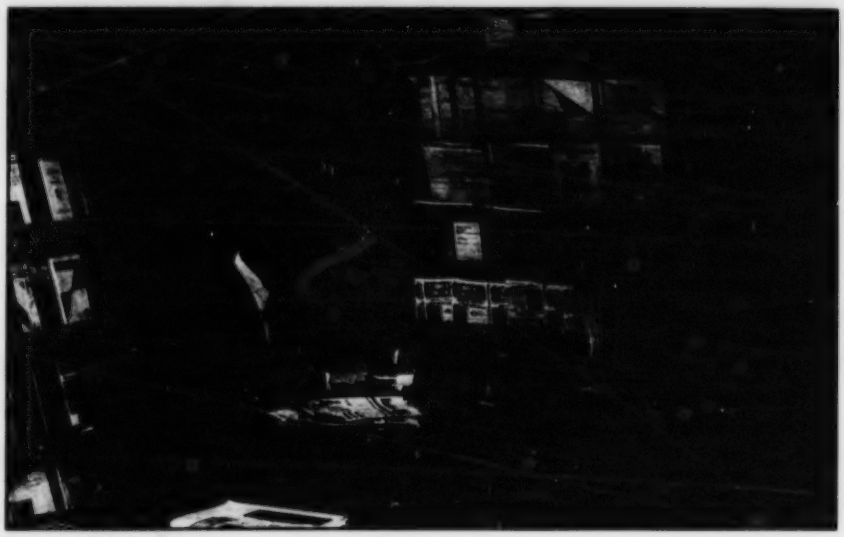
The reduced budget base for the 1987/88 and 1988/89 fiscal years put a heavy demand on administrative operations.

The clerical staff not only carried out all the administrative functions required to support a government scientific operation, but also produced papers, book chapters, and research protocols to a high degree of technical perfection. In all Divisions, new computer systems and software were brought on line to increase the efficiency of administrative and technical operations.

Many Centre staff attended a new course called "Working", on how to work more efficiently with peers and supervisors. A unique aspect of this course is that it was led by selected and trained in-house managers.

Staff members participated in a number of occupational health and safety courses offered at the Centre. Awareness of safety is high and has resulted in an excellent Centre-wide safety record.

In the Chemistry Division, a new safety manual was produced, replacing the one written seven years ago. The revised manual covers the use of new technology and equipment and incorporates up-to-date safety and occupational health regulations. In order to improve the safety record of casual staff, the Chemistry Division reviewed its approach to safety education. A new two-tiered system involves an initial safety meeting and a follow-up meeting to reinforce safe working procedures.



Part of library's scientific journal collection

These safety initiatives won high marks in a provincial government safety audit. The Chemistry Division was one of five government laboratory operations chosen for a general safety audit and it scored very well.

Centre staff actively participated in the implementation of WHMIS (Workplace Hazardous Material Information System) which was legislated for implementation during October 1988.

The Centre is heavily involved in preserving and protecting its local environment. Consequently, waste treatment systems include the Centre's four wastewater treatment systems — storm sewer water, sanitary sewer water, laboratory wastewater, and special pesticide laboratory wastewater — which are the responsibility of the Environmental Technology Division. To minimize the amount of waste going into the sewers, special containers for concentrated chemical wastes have been placed in laboratories. That waste is shipped off-site for treatment and disposal.

In the public relations area, handled by Common Services, a 15-minute video highlighting the Centre's activities was produced. It became part of tours of the Centre and was used when making presentations to schools and other groups. A static display was also completed.

The library service was evaluated to find ways to maintain its effectiveness. A questionnaire developed by the Librarian was distributed to explore the opinions of Centre staff in two areas, attitudes towards the establishment of "Division libraries" and to compare perceptions of library service in 1988 to those of 1986. Though staff did not necessarily oppose the idea of "Division libraries" most preferred one central library. The favourable perception of library service to Centre staff was reaffirmed despite cuts in staff and services available.

A review of all serials subscriptions was undertaken. Serials prices, especially for scientific and technical journals, have been rising at rates greater than inflation, creating a crisis in serials management for all research libraries. The Centre library was faced with this problem and with the need to reduce its expenditures. The review resulted in a 35% reduction in the total number of journals held by the library. The reduction eliminated lower priority hard copy titles and essentially all of the microform subscriptions.

Alberta Environmental Centre Program/Project Lists 1987-89

PROGRAM	PROJECT	CLIENT AGENCY
Administration and Research Support Services	Administrative Services Research Planning and Management Biometrics Services Staff Training and Development Safety Quality Assurance/Good Lab Practice Capital Facilities Development Lab Maintenance Engineering Services Physical Facilities Standard Operating Procedures Photographic Services	Alberta Environmental Centre
Analytical Services	Air and Water Analyses	Environment Alberta Environmental Centre Community and Occupational Health Health Units
Animal Resources	Animal Care and Use Committee Laboratory Animal Acquisition and Maintenance Livestock Acquisition and Maintenance Aquatic Animal Acquisition and Maintenance Wildlife Animal Acquisition and Maintenance	Alberta Environmental Centre Environment
Aquatic Toxicology	Toxicity Evaluation of Industrial Wastewaters Toxicity Evaluation of Municipal Wastewaters	Forestry, Lands and Wildlife Environment Alberta Environmental Centre
Biological Control of Weeds	Priority List of Weeds Survey of Arthropods Biology and Host-specificity Release and Monitoring Post-establishment Studies Biocontrol with Pathogens	Agriculture
Biology and Ecology of Weeds	Biology of Weeds of Alberta Weed-Crop Competition Weed Surveys and Population Dynamics Biology and Control of Aquatic Weeds	Agriculture; Energy Environment Recreation and Parks Alberta Environmental Centre Forestry, Lands and Wildlife

PROGRAM	PROJECT	CLIENT AGENCY
Chemical Residues	Speciation of Heavy Metals Geochemistry of Mercury in Southern Alberta Mercury Residues in Fish Chemical Residues in Colonial Nesting Birds Chemical Residues in Peregrine Falcons	Forestry, Lands and Wildlife Environment Alberta Environmental Centre
Chemical Safety Evaluation	Acute Toxicity Studies	Technology, Research and Telecommunications Agriculture; Environment Community and Occupational Health Alberta Environmental Centre
Controlled Environment Services	Growth Chambers and Greenhouses	Alberta Environmental Centre
Ecological Studies	Problem Wildlife Research Aquatic Habitat Studies Forestry Development and Wildlife Resources Wildlife Productivity	Environment Forestry, Lands and Wildlife Agriculture
Electron Microscopy Services	Transmission Electron Microscopy Energy Dispersive X-Ray Analyses	Community and Occupational Health Agriculture; Environment Health Units Alberta Environmental Centre
Engineering and Computing Services	Repair and Maintenance of Laboratory Instruments Engineering and Systems Design Research Computing Development Research Computing Operations EDP Telecommunication One-Site Environmental Services Engineering Services	Alberta Environmental Centre Environment
Environmental Isotopes	Development of Methods and Systems Radiation Liaison Services C-14 and H-3 Environmental Research and Applications Stable Isotope Environmental Research and Applications	Agriculture; Environment Alberta Research Council Culture; Energy Alberta Environmental Centre

PROGRAM	PROJECT	CLIENT AGENCY
Herbicides and Weed Management	Performance Evaluation of Herbicides Crop Safety and Tolerance to Herbicides Behaviour and Fate of Herbicides in Soil Environmental Factors and Performance of Herbicides Chemical Damage Diagnostic Techniques	Agriculture Environment Alberta Environmental Centre
Humane Trapping	Power Snare Evaluation Mechanical Killing Devices for Small Furbearers Mechanical Evaluation of Candidate Traps	Forestry, Lands and Wildlife Agriculture Fur Institute of Canada
Inhalation Toxicology	Biochemical Effects of Sulphur Gases Inhalation Toxicology Systems Development Acute Effects of Sulphur Gases Chronic Effects of Sulphur Gases Reproductive Effects of Sulphur Gases Hydrogen Sulphide Toxicosis in Domestic Livestock	Community and Occupational Health Agriculture Environment Alberta Environmental Centre
Insect Pest Management	Special Crops Insect Pest Management Field Crops Insect Pest Management Livestock Insect Pest Management	Agriculture
Microbiological Services	Microbiological Enumeration Services Microbiological Identification Services Microbial Toxicity Service Microbiological Processes in Waste Management	Agriculture Environment Alberta Environmental Centre
Native Species for Reclamation	Native Species for Reclamation - East Slopes Native Species for Reclamation - Northern Alberta Native Species for Reclamation - Southern Alberta	Environment; Energy Alberta Environmental Centre Public Works, Supply and Services
Pathology Services	Necropsy Service Histopathology Service Clinical Pathology Service Ultrastructural Pathology Service	Alberta Environmental Centre

PROGRAM	PROJECT	CLIENT AGENCY
Pest Management Diagnostic and Extension Services	Insect Diagnostic and Extension Services Plant Disease Diagnostic and Extension Services Weed Diagnostic and Extension Services Chemical Damage Diagnostic and Extension Services	Agriculture Community and Occupational Health Environment Alberta Environmental Centre
Pesticide Analysis and Methods Development	Interdisciplinary Pesticide Research	Community and Occupational Health Forestry, Lands and Wildlife Agriculture; Environment Alberta Environmental Centre
Plant Pathology	Disease Management in Cereal, Oilseed and Special Crops Disease Management in Forage Crops	Agriculture; Environment Alberta Environmental Centre
Potable Water Technology	Treatability of Surface Waters Subject to Effluents from Pulp Mills Giardia Cyst Removal and Inactivation Groundwater Treatment Colour, Taste and Odour Mobile Water Treatment Plant	Public Works, Supply and Services Alberta Environmental Centre Environment Agriculture
Precipitation Studies	Long Range Transport of Air Pollutants	Environment Alberta Environmental Centre
Quality Control and Data Management Services	Quality Assurance and Quality Control Monitoring	Community and Occupational Health Energy; Environment Alberta Environmental Centre Health Units
Site Support Services	Research Plots and Animal Facilities Vehicle and Equipment Maintenance	Alberta Environmental Centre
Soil Reclamation Research	Soil Analytical Services Water Use and Salt Transport Water Balance: Sodic Soils Soil Compaction Biological Dewatering Inventions and Methods Legal Analytical Samples	Agriculture Energy Forestry, Lands and Wildlife

PROGRAM	PROJECT	CLIENT AGENCY
Technical Services (Animal Sciences)	Wildlife Biology Services Analytical Toxicology Toxicology Services Aquatic Biology Services	Agriculture Forestry, Lands and Wildlife Environment Alberta Environmental Centre
Technology Development in Waste Management	Incineration Solidification Fermentation Cellulosic Waste Utilization Research and Development Services	Agriculture Environment Alberta Environmental Centre Special Waste Management Corporation
Toxicology of Biocides	Environmental Effects of Grasshopper Control Activities Toxicology of Methoxychlor to Fish Toxicology of Insecticides to Livestock Biological Control of Aquatic Weeds with Grass Carp	Agriculture Forestry, Lands and Wildlife Environment Alberta Environmental Centre
Toxicology of Petrochemicals and Fossil Fuels	Experimental Toxicity of Crude Petroleum Toxicology of Petroleum Hydrocarbons to Fish Toxicity of Tar Sand Holding Pond Effluent Toxicity of Crude Petroleum to Livestock Toxicity of Petrochemicals	Agriculture Energy Environment Alberta Environmental Centre Forestry, Lands and Wildlife
Trace Organic Analysis and Methods Development	Interdisciplinary Organic Containment Research	Community and Occupational Health Forestry, Lands and Wildlife Environment; Health Units Alberta Environmental Centre

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* James Mason
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* *Indicates employee left between March 31, 1987 and March 31, 1989*

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Fiscal Year Expenditures

1987-88 (Thousands of Dollars)

	Manpower	*Supplies and Services*	*Grants*	*Fixed Assets*	*Total*
Common Services	1208	1047	0	39	2294
Plant Sciences	1315	283	0	43	1641
Chemistry	2112	266	0	67	2445
Animal Sciences	1546	460	0	99	2105
Environmental Technology	1215	351	0	267	1833
Total	7396	2407	0	515	10308

1988-89 (Thousands of Dollars)

	Manpower	*Supplies and Services*	*Grants*	*Fixed Assets*	*Total*
Common Services	1118	1573	300	23	3014
Plant Sciences	1343	1363	0	85	1564
Chemistry	2107	253	0	69	2492
Animal Sciences	1552	405	0	79	2036
Environmental Technology	1258	354	0	150	1762
Total	7441	2721	300	406	10868

Organization Chart